

mentary to that of the corpus callosum. This is, moreover, a special characteristic of the lowest group of the mammalia, most remarkable because it is entirely lost in the next step of descent in the vertebrated classes.

After a description of the brain of a bird, the conclusion is arrived at that, great as is the difference between the placental and implacental mammal in the nature and extent of the connexion between the two lateral hemispheres of the cerebrum, it is not to be compared with that which obtains between the latter and the oviparous vertebrate.

IV. "Note on the Atomicity of Aluminium." By Professor A.W. WILLIAMSON, F.R.S., President of the Chemical Society. Received February 6, 1865.

In the "Preliminary Note on some Aluminium Compounds," by Messrs. Buckton and Odling, published in the last Number of the Society's 'Proceedings,' some questions of considerable theoretical importance are raised in connexion with the anomalous vapour-densities of aluminium ethyle and aluminium methyle. The authors have discovered that the vapour of aluminium methide ( $\text{Al}^2 \text{Me}^6$ ) occupies rather more than two volumes ( $\text{H}=1$  vol.) at  $163^\circ$ , when examined by Gay-Lussac's process, under less than atmospheric pressure. The boiling-point of the compound under atmospheric pressure is given at  $130^\circ$ , and the compound accordingly boiled a good deal below  $130^\circ$  at the reduced pressure at which the determination was made. The vapour was therefore considerably superheated when found to occupy a little more than two volumes. When still further superheated up to  $220^\circ$  to  $240^\circ$ , it was found to possess a density equivalent to rather less than four volumes at the normal temperature and pressure.

The aluminium ethyle was found to have a density decidedly in excess of the formula  $\text{Al}^2 \text{Et}^6 = 4$  vols., but far too small for  $\text{Al}^3 \text{Me}^6 = 2$  vols. From their analogy to aluminic chloride,  $\text{Al}^2 \text{Cl}^6 = 2$  vols., the methide and ethide might be expected to have vapour-volumes corresponding to  $\text{Al}^2 \text{Me}^6 = 2$  vols.,  $\text{Al}^2 \text{Et}^6 = 2$  vols. The authors seem, however, more inclined to doubt the truth of the general principles which lead us to consider these hexatomic formulæ the correct ones, than to doubt their own interpretation of the observations already made upon the new compounds.

Even if the vapour-volume of aluminic chloride had been unknown to us, there were ample grounds for assigning to aluminium methide a molecular formula  $\text{Al}^2 \text{Me}^6$ , and a vapour-density corresponding to  $\text{Al}^2 \text{Me}^6 = 2$  vols.; for the close analogy of aluminic and ferric salts is perfectly notorious, and the constitution  $\text{Fe}^3 \text{O}^3$  for ferric oxide settles  $\text{Al}^2 \text{O}^3$  as the formula for alumina. With regard, however, to the chlorides of these metals, it might be supposed that the formula  $\text{Fe Cl}^3$  and  $\text{Al Cl}^3$  would be the most probable molecular formulæ; and Dr. Odling, in his useful Tables of Formulæ, published in 1864, expressed an opinion in favour of these formulæ by classing

as anomalous Deville's vapour-densities, which correspond to the higher formulæ  $\text{Al}^2 \text{Cl}^6$ ,  $\text{Fe}^2 \text{Cl}^6$ . It is well known that Laurent and Gerhardt, whose penetrating minds raised so many vital questions of chemical philosophy, laid down a preliminary rule that every molecule must contain an even sum of the atoms of chlorine, hydrogen, nitrogen, and metals. According to this rule, the formulæ  $\text{Al}^2 \text{Cl}^6$  and  $\text{Fe}^2 \text{Cl}^6$  would have no greater probability than the formulæ  $\text{FeCl}^3$ ,  $\text{AlCl}^3$ ; and judging by that rule, Dr. Odling naturally preferred the simpler formulæ.

Since Gerhardt's time chemists have, however, extended to the greater number of metals the arguments which proved oxygen to be biatomic; and we now know that the alkali-metals, the nitrogen series, silver, gold, and boron, may count with the atoms of chlorine, hydrogen, &c. to make up an even number in each molecule, but that the greater number of metals must not be so counted; for that in each molecule in which they are contained the sum of the atoms of chlorine, hydrogen, nitrogen, potassium, &c. must be even, just as much as if the atom of the diatomic or tetratomic metal were not in the compound. In a paper "On the Classification of the Elements in relation to their Atomicities," I had occasion to point out that inasmuch as iron and aluminium belong, partly by their own properties, partly by their analogies, to the class of metals which do not join with chlorine, &c. in making up an even number of atoms, the number of those other atoms in each molecule must be even in itself, just as if iron or aluminium were not there; and that accordingly the formulæ  $\text{Fe}^2 \text{Cl}^6$ ,  $\text{Al}^2 \text{Cl}^6$  are really quite normal. In like manner I showed that the vapour-density of calomel,  $\text{HgCl} = 2$  vols., is anomalous, as containing in a molecular volume a single atom of chlorine, although, in accordance with Gerhardt's rule, Dr. Odling had classed it as normal. I certainly understood that my able friend accepted my suggestion in this case at least, for he speedily brought forward theoretical and experimental facts in confirmation of it.

These examples serve to show that it was to be expected that the ethyle and methyle compounds of aluminium would contain an even number of atoms of ethyle and methyle in each molecule, and that their formulæ would accordingly be  $\text{Al}^2 \text{Me}^6$ ,  $\text{Al}^2 \text{Et}^6$ .

It remains for us to consider how the deviation from our theoretical anticipations in the case of aluminium ethyle and the partial deviation in the case of aluminium methyle ought to be treated.

Fortunately we have the benefit of some experience to guide us in this matter, for a considerable number of other compounds have been found to occupy in the state of vapour nearly double the volume which corresponds to one molecule; but, with very few exceptions, all of them have already been proved to have undergone decomposition, so as to consist of two uncombined molecules. Thus sal-ammoniac is admitted to have the molecular formula  $\text{NH}^4 \text{Cl}$ ; yet in the state of vapour this quantity occupies the volume of nearly two molecules, viz. four volumes. Has the anomaly led us to doubt the atomic weight of chlorine, nitrogen, or hy-

drogen, or to doubt any other of the results of our comparison of their compounds? or has it led chemists to diffusion experiments with its vapour, proving it to contain uncombined HCl and  $\text{NH}_3$ , each occupying its own natural volume? Has it not been proved that at the temperature at which sal-ammoniac vapour was measured, its constituents mix either without evolving heat (that invariable function of chemical action), or, according to another experimentalist, with evolution of far less heat than of the whole quantity of hydrochloric acid and ammonia combined, on coming together at that high temperature?

Again,  $\text{SO}^4\text{H}^2$  is known to represent the formula of one molecule of hydric sulphate, yet the vapour formed from it occupies nearly the bulk of two molecules. Has this fact cast any doubt on the atomic weights of the elements S, O, or H? Or has it led to the discovery of peculiarities in the constitution of the vapour which would probably have escaped notice had they not been anticipated by theory, peculiarities which go a long way towards bringing the apparent anomalies within the law?

Nitric peroxide,  $\text{N}^2\text{O}^4$ , was considered, from our knowledge of other volatile compounds of nitrogen, to be anomalous in its vapour-volume being  $\text{N}^2\text{O}^4=4$  vols.; and we have been shown by the experiment of Messrs. Playfair and Wanklyn, that the anomaly almost disappears when the compound is evaporated by the aid of a permanent gas at a temperature considerably below its boiling-point, as its theoretical molecule  $\text{N}^2\text{O}^4$  is then found to occupy the two volumes which every undecomposed molecule occupies. This explanation seems to me to be the more entitled to grave consideration on the part of the discoverers of the new aluminium compounds, from the fact that the evidence in favour of it has been admitted to be conclusive by Dr. Odling, who classes nitric peroxide by the formula  $\text{N}^2\text{O}^4=2$  vols. among compounds with normal vapour-densities, in virtue of the fact that at low temperatures it can be obtained with that density, though having half that density at higher temperatures.

The arguments for admitting that the low vapour-densities of the aluminium compounds are anomalous are even stronger than those which are admitted in the case of nitric peroxide; for it did require very severe superheating to get the aluminium compounds to near four volumes, whereas it required very ingenious devices to get nitric peroxide out of the four-volume state.

Such guiding principles as we have acquired in chemistry are the noblest fruits of the accumulated labours of numberless patient experimentalists and thinkers; and when any new or old fact appears to be at variance with those principles, we either add to our knowledge by discovering new facts which remove the apparent inconsistency, or we put the case by for a while and frankly say that we do not understand it.

The decision of the atomic weight of aluminium has involved greater difficulty than was encountered in the case of most other metals, owing to the fact of our knowing only one oxide of the metal, and salts correspond-

ing to it; but the analogies which connect aluminium with other metals are so close and so numerous, that there are probably few metals of which the position in our classification is more satisfactorily settled. We may safely trust that the able investigators who are examining these interesting compounds will bring them more fully than now within the laws which regulate the combining proportions of their constituent elements; for, as it now stands, the anomaly is far less than many others which have been satisfactorily explained by further investigations.

Meanwhile aluminium is a metal singular for only appearing in that pseudo-triatomic character in which iron and chromium appear in their sesquisalts.

February 16, 1865.

Dr. W. A. MILLER, Treasurer and Vice-President, in the Chair.

The following communications were read:—

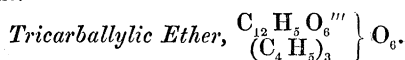
- I. "On the Synthesis of Tribasic Acids." By MAXWELL SIMPSON, M.D., F.R.S. Received January 25, 1865.

(Abstract.)

In a former Number of the 'Proceedings' \* I gave a preliminary notice of a tribasic acid having the composition  $C_{12}H_8O_{12}$ , formed by the action of potash on tereyanide of allyle. The process for the preparation of the acid given in that paper I have since succeeded in improving very considerably, so that I can now obtain it in quantity and with tolerable facility. An account of the improved process is contained in the general paper which accompanies this abstract. The paper also contains a description of the crystalline form of the acid, for which I am indebted to Professor Miller of Cambridge.

M. Kekulé† proposes to call this body carballylic acid. This name I cannot, however, accept without some modification, as recent researches‡ have proved that it belongs by right to crotonic acid. I propose therefore, in order to avoid confusion, to call it *tricarballylic acid*.

Since the appearance of my preliminary paper, I have also prepared and analyzed several of the salts and ethers of this acid, of which the following is a short account.



This ether is readily prepared by conducting a stream of dry hydrochloric acid gas into a solution of tricarballylic acid in absolute alcohol. The product obtained on evaporating the alcohol distils between  $295^\circ$  and  $305^\circ$  C.

\* Proceedings of the Royal Society, vol. xii. p. 236.

† Lehrbuch der Organischen Chemie, vol. ii. p. 187.

‡ Annalen der Chemie und Pharmacie, vol. cxxxi. p. 58.